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United States Patent

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Park et al.

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(54) **SENSOR TAG AND METHOD OF PROVIDING SERVICE USING THE SAME**

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Oct. 16, 2013 (KR) 10-2013-0123561

(51) **Int. Cl.**

G06K 7/08	(2006.01)
G06F 17/30	(2006.01)
A61B 5/00	(2006.01)
G06K 19/07	(2006.01)
H04Q 9/00	(2006.01)
A61B 5/02	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 17/30*** (2013.01); ***A61B 5/002*** (2013.01); ***G06K 19/0704*** (2013.01); ***G06K 19/0707*** (2013.01); ***G06K 19/0716*** (2013.01); ***G06K 19/0717*** (2013.01); ***H04Q 9/00*** (2013.01); *A61B 5/02* (2013.01); *A61B 2560/0242* (2013.01); *A61B 2562/08* (2013.01); *H04Q 2209/47* (2013.01); *H04Q 2209/823* (2013.01); *H04Q 2209/886* (2013.01)

(58) **Field of Classification Search**

CPC G06K 19/0723
USPC 235/451
See application file for complete search history.

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Primary Examiner — Jamara Franklin
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

A sensor tag includes: a tag chip that receives a supply of a driving voltage that is generated from a radio frequency (RF) signal that is received from a reader and that transmits sensor data to the reader according to a request from the reader; at least one sensor that receives a supply of a necessary driving voltage from the tag chip and that measures corresponding sensor data; and a micro controller unit (MCU) that receives a supply of a necessary driving voltage from the tag chip and that transfers sensor data that is measured from the at least one sensor to the tag chip.

20 Claims, 21 Drawing Sheets

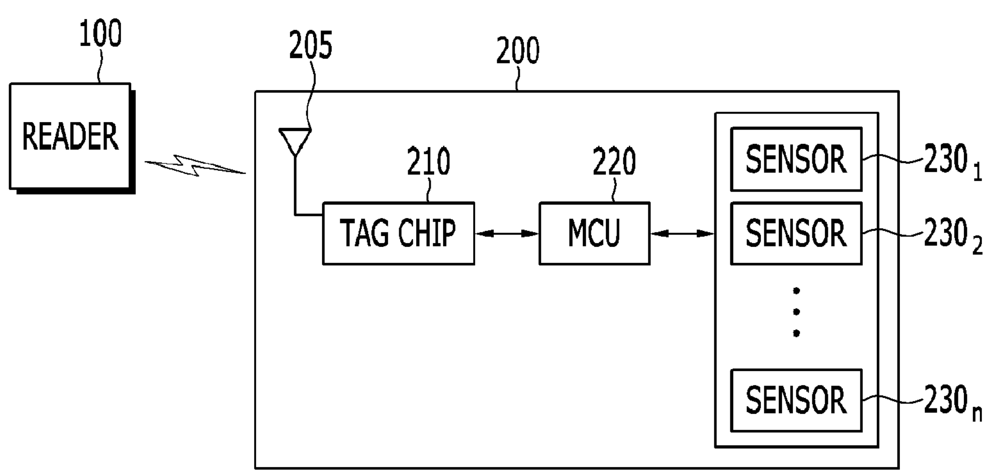


FIG. 1

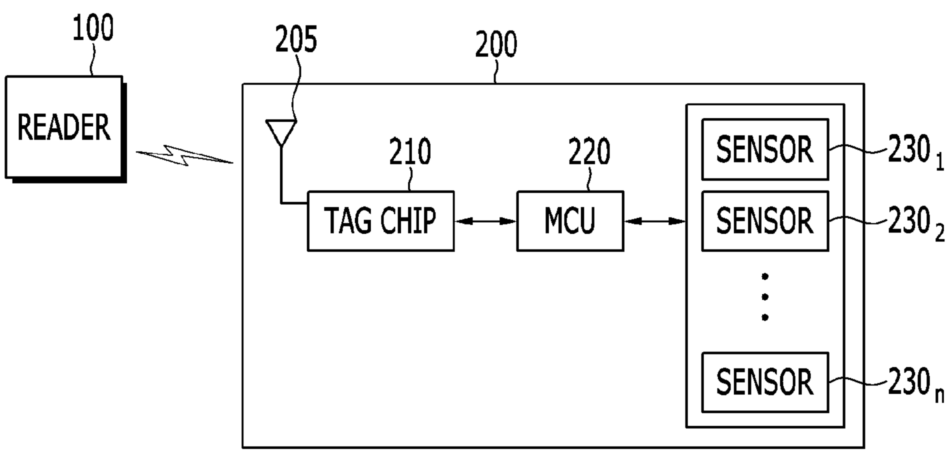

100
READER
205
200
210
220
TAG CHIP
MCU
SENSOR
SENSOR
SENSOR
230_1
230_2
230_n

FIG. 2

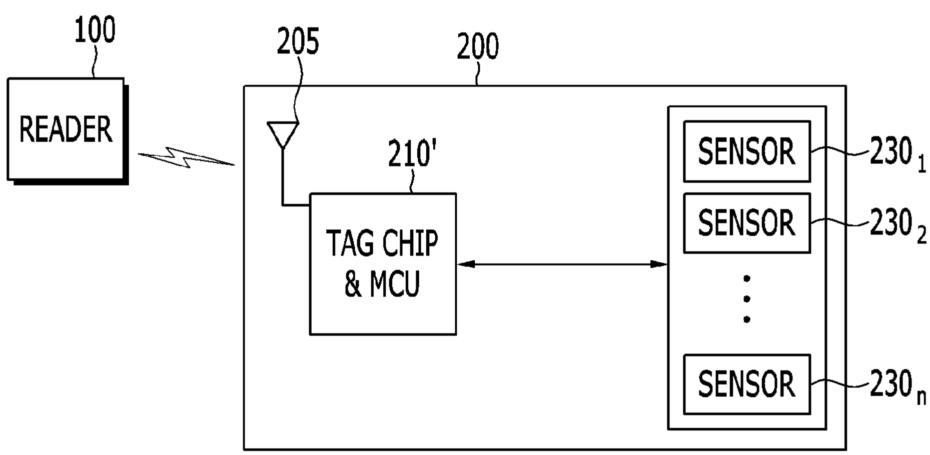

100
READER
205
200
210'
TAG CHIP
& MCU
SENSOR
SENSOR
SENSOR
230 1
230 2
230 n

FIG. 3

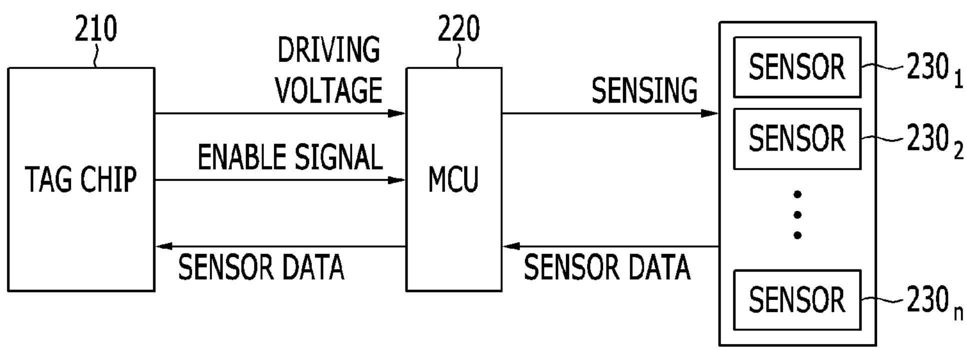

210
TAG CHIP
DRIVING VOLTAGE
ENABLE SIGNAL
SENSOR DATA
220
MCU
SENSING
SENSOR DATA
SENSOR
SENSOR
SENSOR
230_1
230_2
230_n

FIG. 4

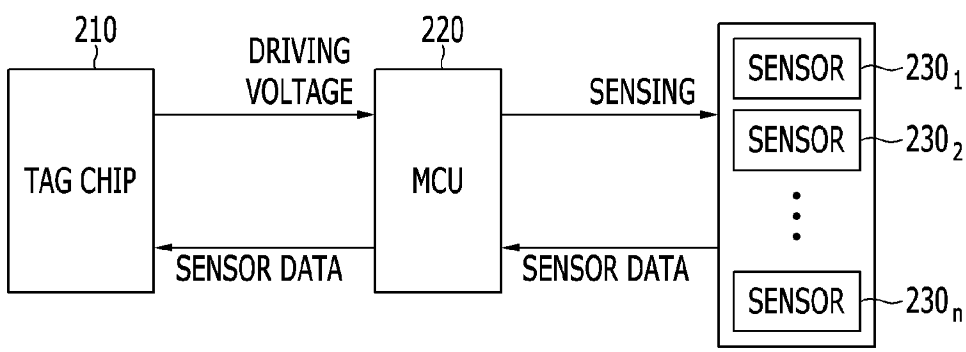
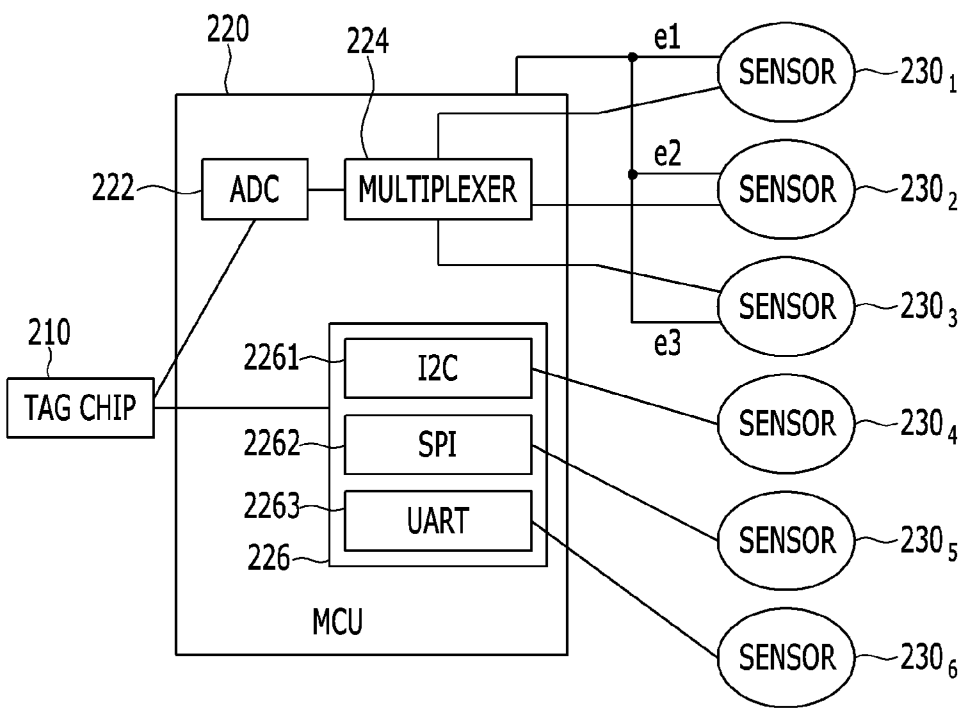

210
TAG CHIP
DRIVING VOLTAGE
SENSOR DATA
220
MCU
SENSING
SENSOR DATA
SENSOR
SENSOR
SENSOR
230₁
230₂
230ₙ

FIG. 5



220
224
222
ADC
MULTIPLEXER
e1
e2
e3
SENSOR
230_1
230_2
230_3
230_4
230_5
230_6
210
TAG CHIP
2261
I2C
2262
SPI
2263
UART
226
MCU

FIG. 6

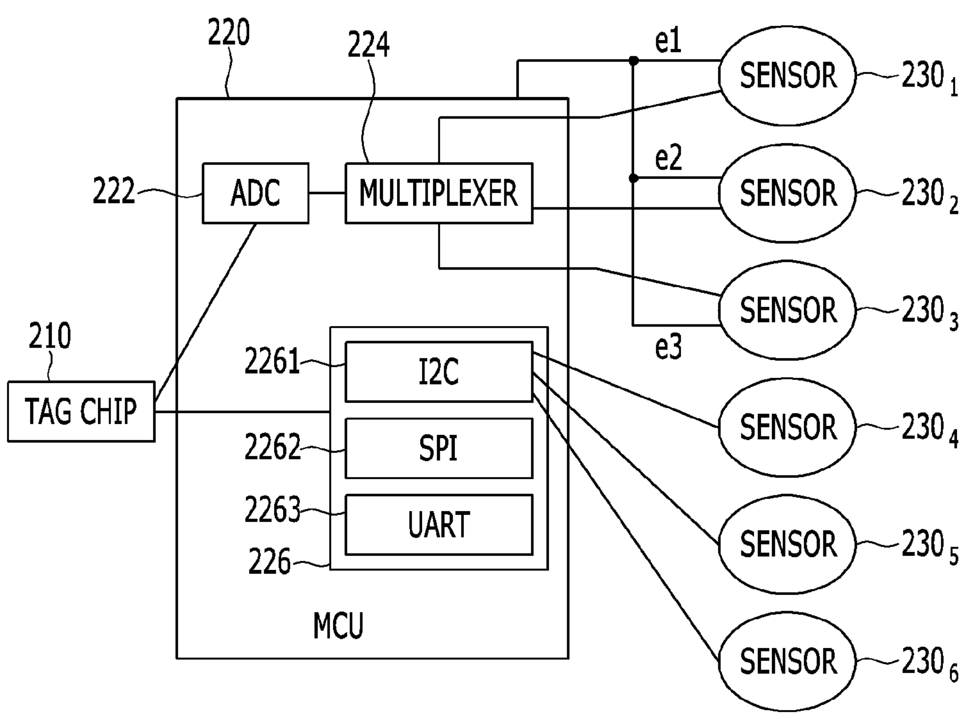

220
224
e1
SENSOR
230_1
222
ADC
MULTIPLEXER
e2
SENSOR
230_2
SENSOR
230_3
210
e3
2261
I2C
TAG CHIP
SENSOR
230_4
2262
SPI
2263
UART
SENSOR
230_5
226
MCU
SENSOR
230_6

FIG. 7

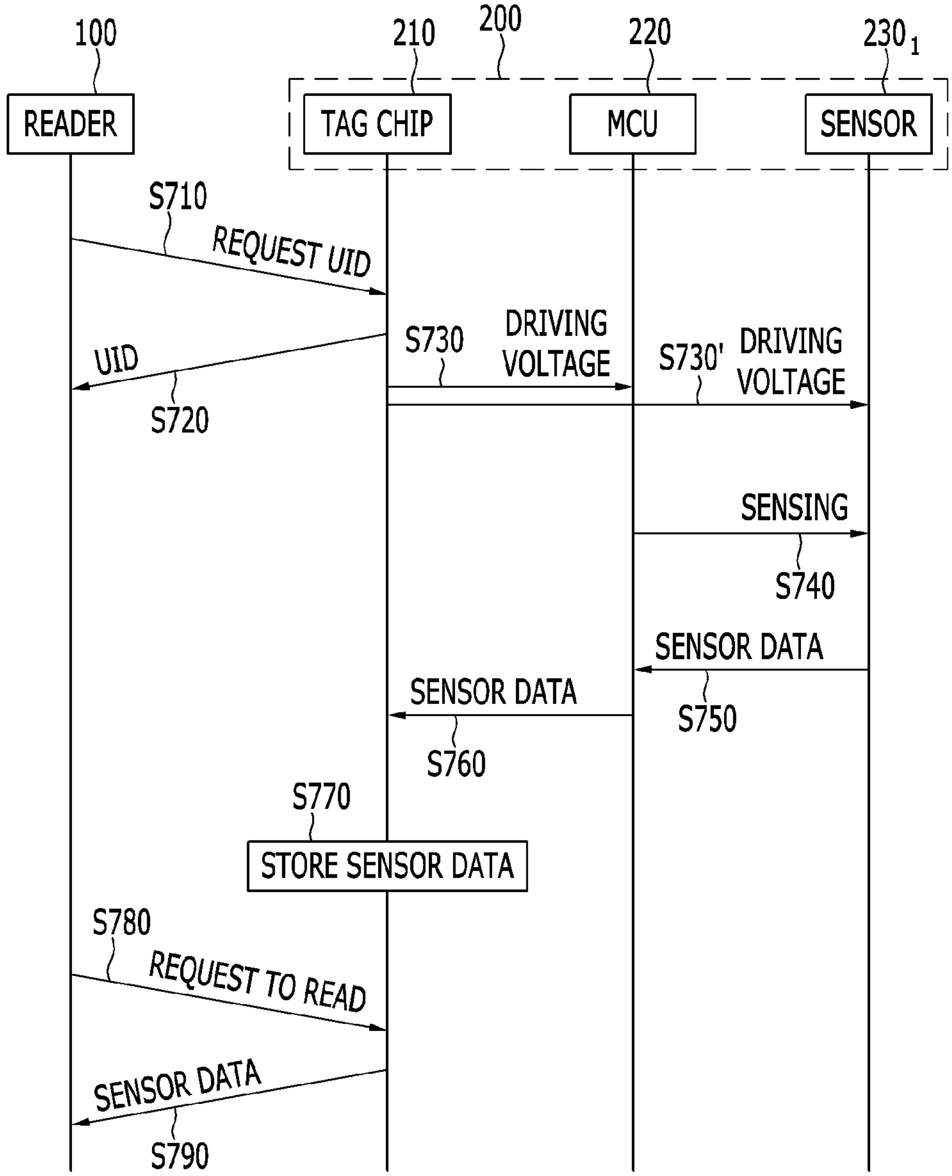

100
210
200
220
230_1
READER
TAG CHIP
MCU
SENSOR
S710
REQUEST UID
UID
S720
S730
DRIVING VOLTAGE
S730'
DRIVING VOLTAGE
SENSING
S740
SENSOR DATA
S750
SENSOR DATA
S760
S770
STORE SENSOR DATA
S780
REQUEST TO READ
SENSOR DATA
S790

FIG. 8

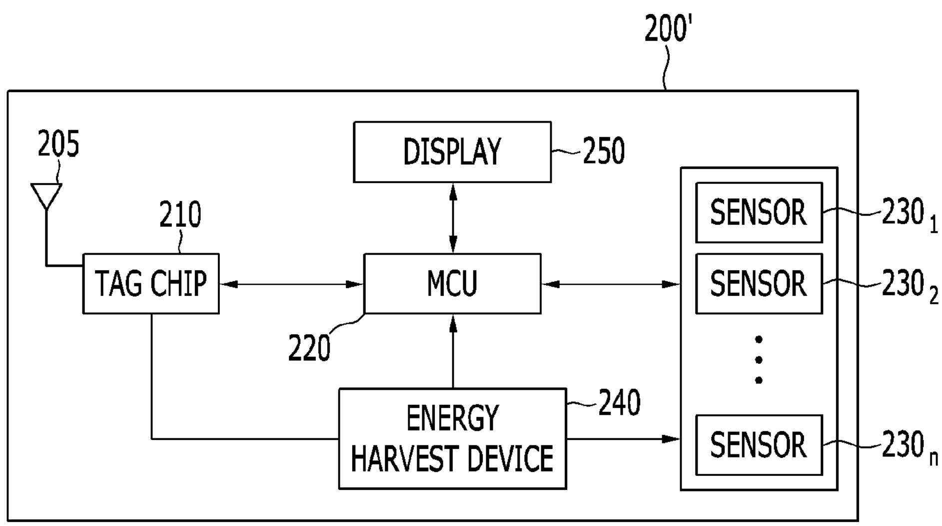

200'
205
210
TAG CHIP
DISPLAY
250
MCU
220
ENERGY
HARVEST DEVICE
240
SENSOR
230_1
SENSOR
230_2
SENSOR
230_n

FIG. 9

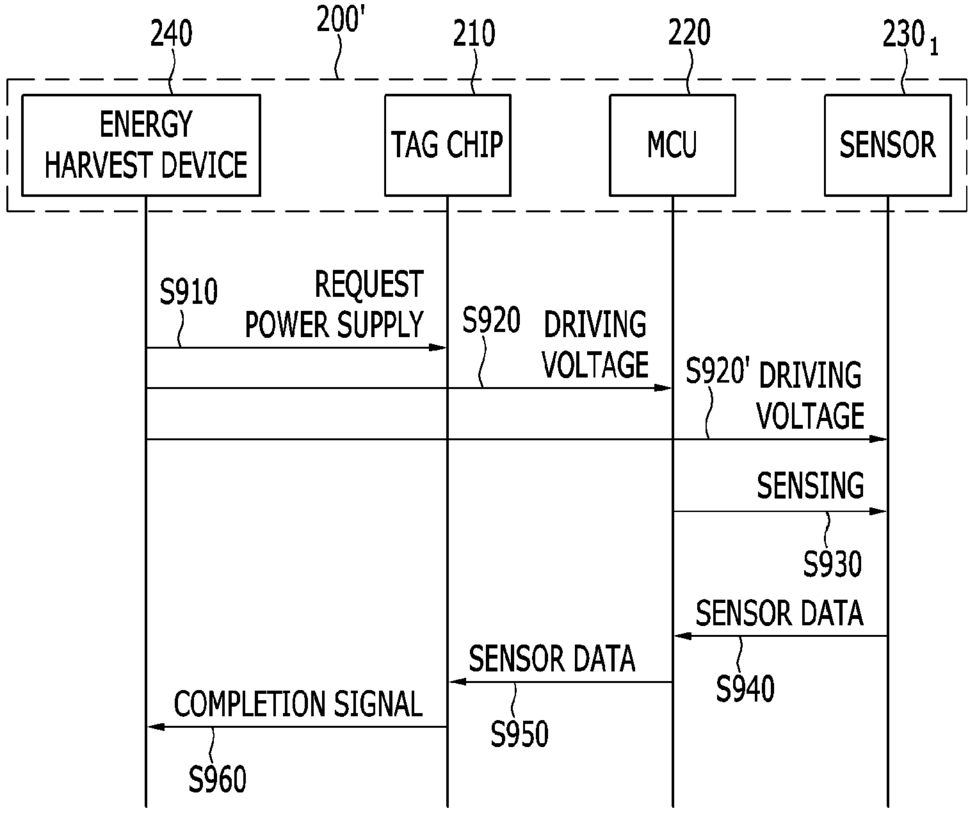

240
200'
210
220
230_1
ENERGY HARVEST DEVICE
TAG CHIP
MCU
SENSOR
S910
REQUEST POWER SUPPLY
S920
DRIVING VOLTAGE
S920'
DRIVING VOLTAGE
SENSING
S930
SENSOR DATA
S940
SENSOR DATA
S950
COMPLETION SIGNAL
S960

FIG. 10

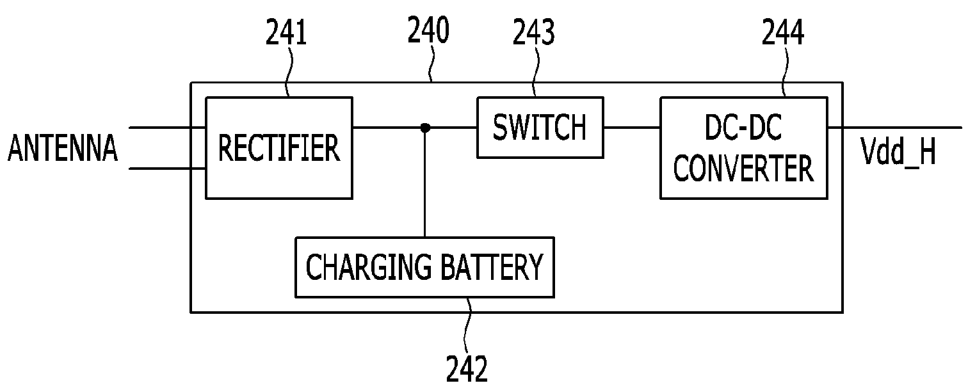

241
240
243
244
ANTENNA
RECTIFIER
SWITCH
DC-DC
CONVERTER
Vdd_H
CHARGING BATTERY
242

FIG. 11

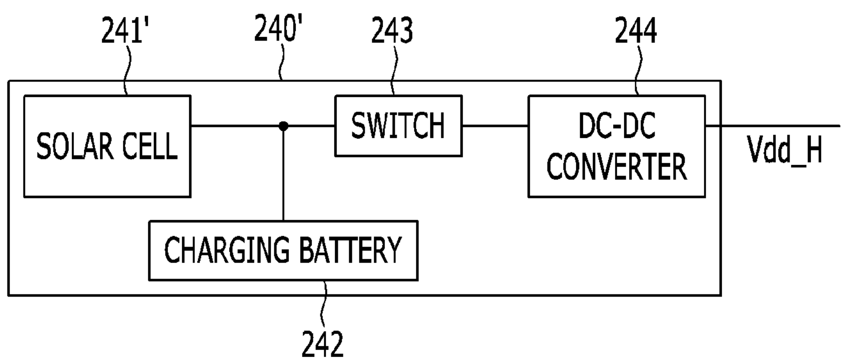
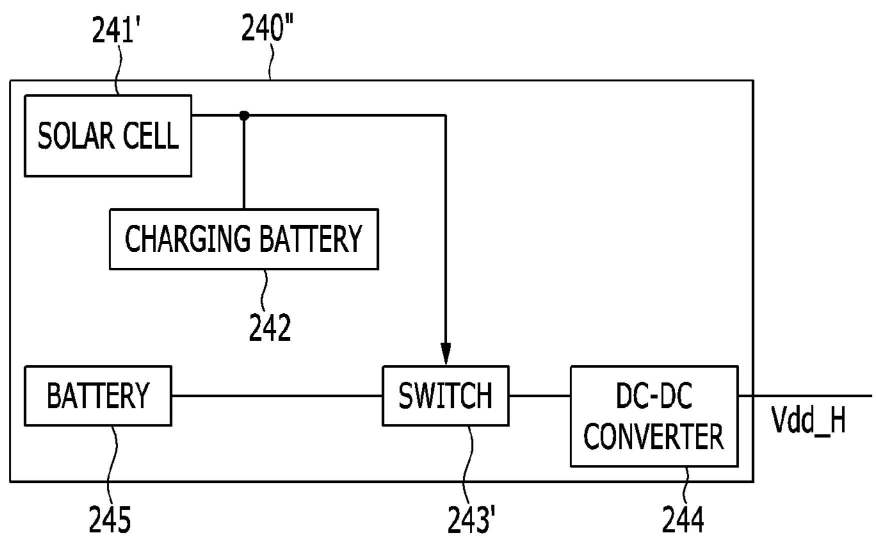

241'
240'
243
244
SOLAR CELL
SWITCH
DC-DC CONVERTER
Vdd_H
CHARGING BATTERY
242

FIG. 12


241'
240"
SOLAR CELL
CHARGING BATTERY
242
BATTERY
SWITCH
DC-DC CONVERTER
Vdd_H
245
243'
244

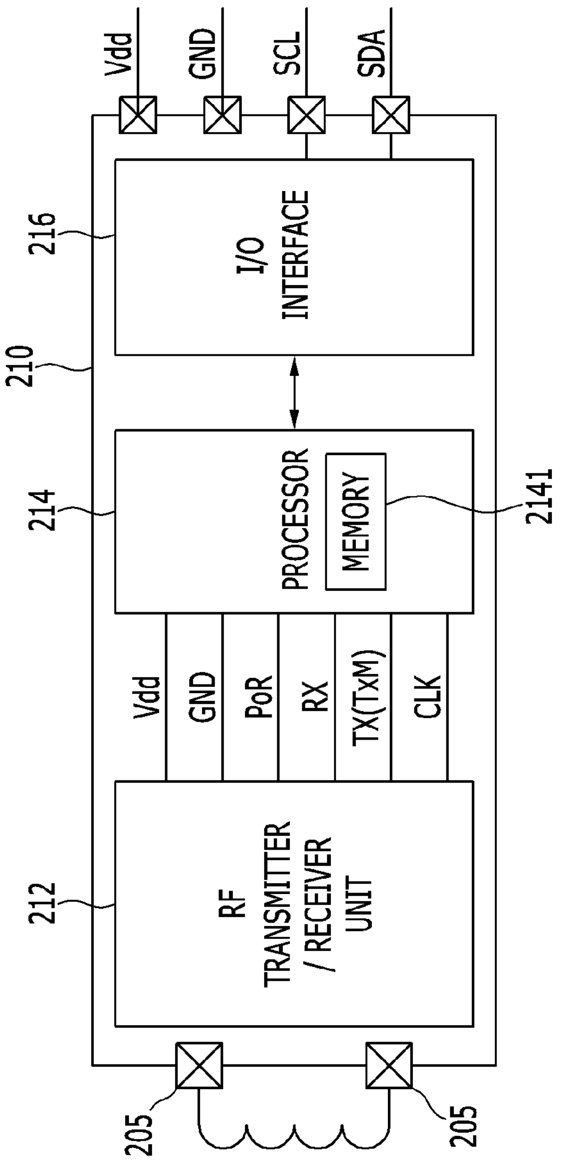

Vdd
GND
SCL
SDA
216
I/O INTERFACE
210
214
PROCESSOR
MEMORY
2141
Vdd
GND
PoR
RX
TX(TxM)
CLK
212
RF TRANSMITTER / RECEIVER UNIT
205
205

FIG. 13

FIG. 14

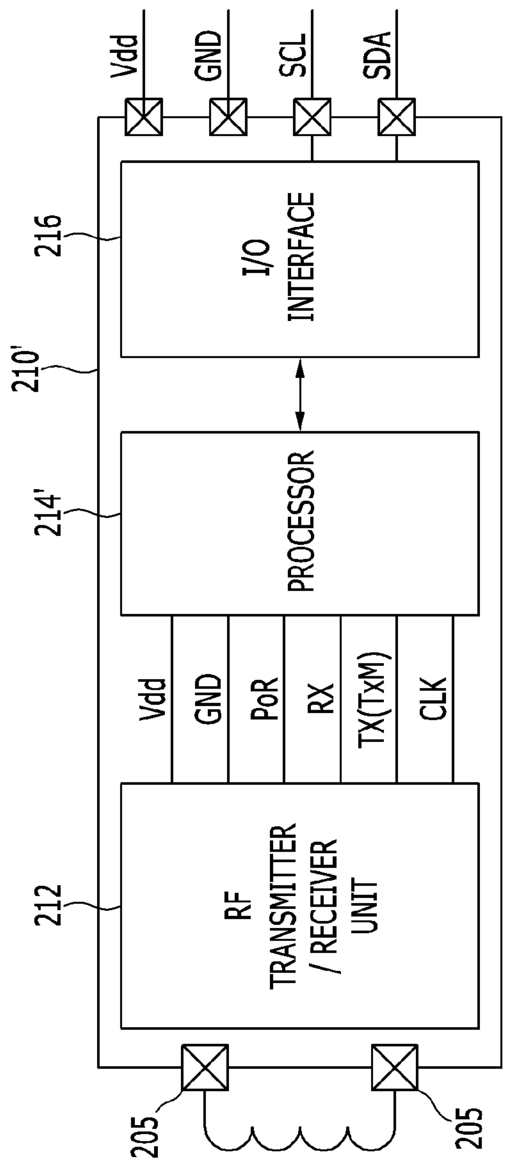

Vdd
GND
SCL
SDA
216
I/O INTERFACE
210'
214'
PROCESSOR
Vdd
GND
PoR
RX
TX(TxM)
CLK
212
RF TRANSMITTER / RECEIVER UNIT
205
205

FIG. 15

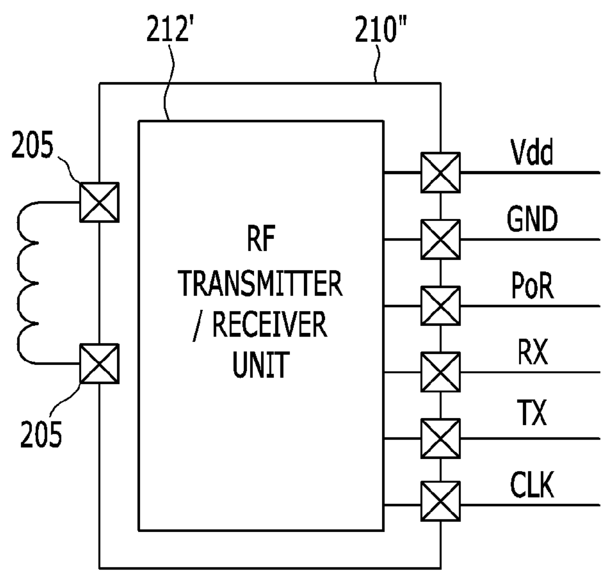

212'
210"
205
RF
TRANSMITTER
/ RECEIVER
UNIT
Vdd
GND
PoR
RX
TX
CLK
205

FIG. 16

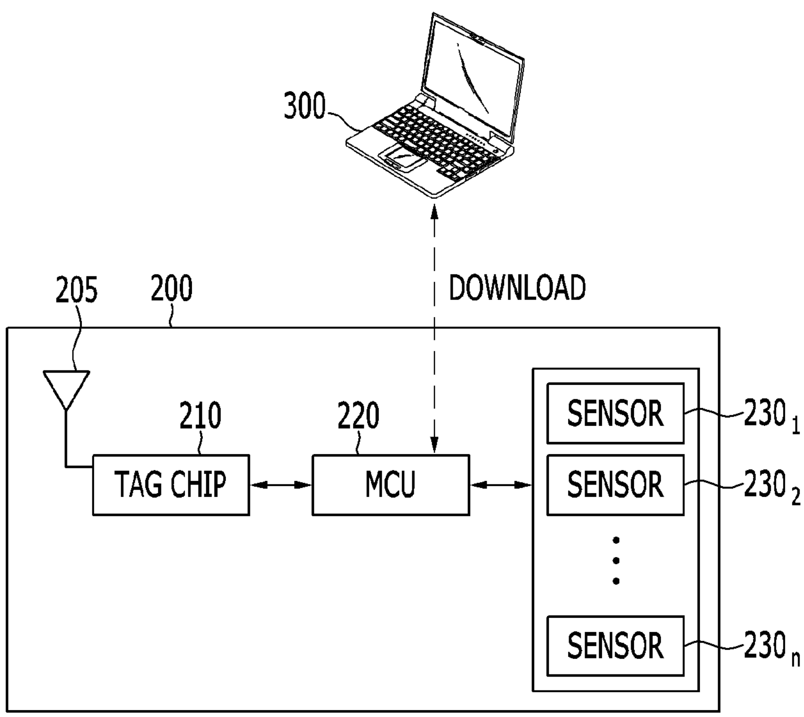

300
DOWNLOAD
205
200
210
220
TAG CHIP
MCU
SENSOR
SENSOR
SENSOR
230 1
230 2
230 n

FIG. 17

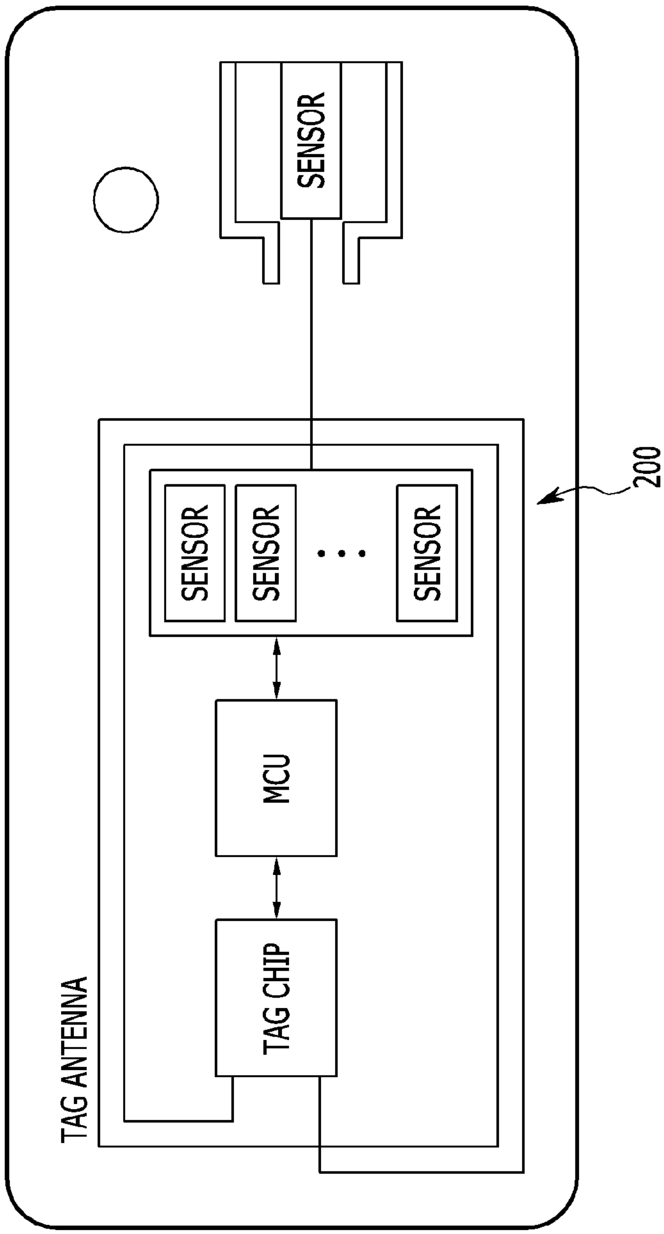


FIG. 18

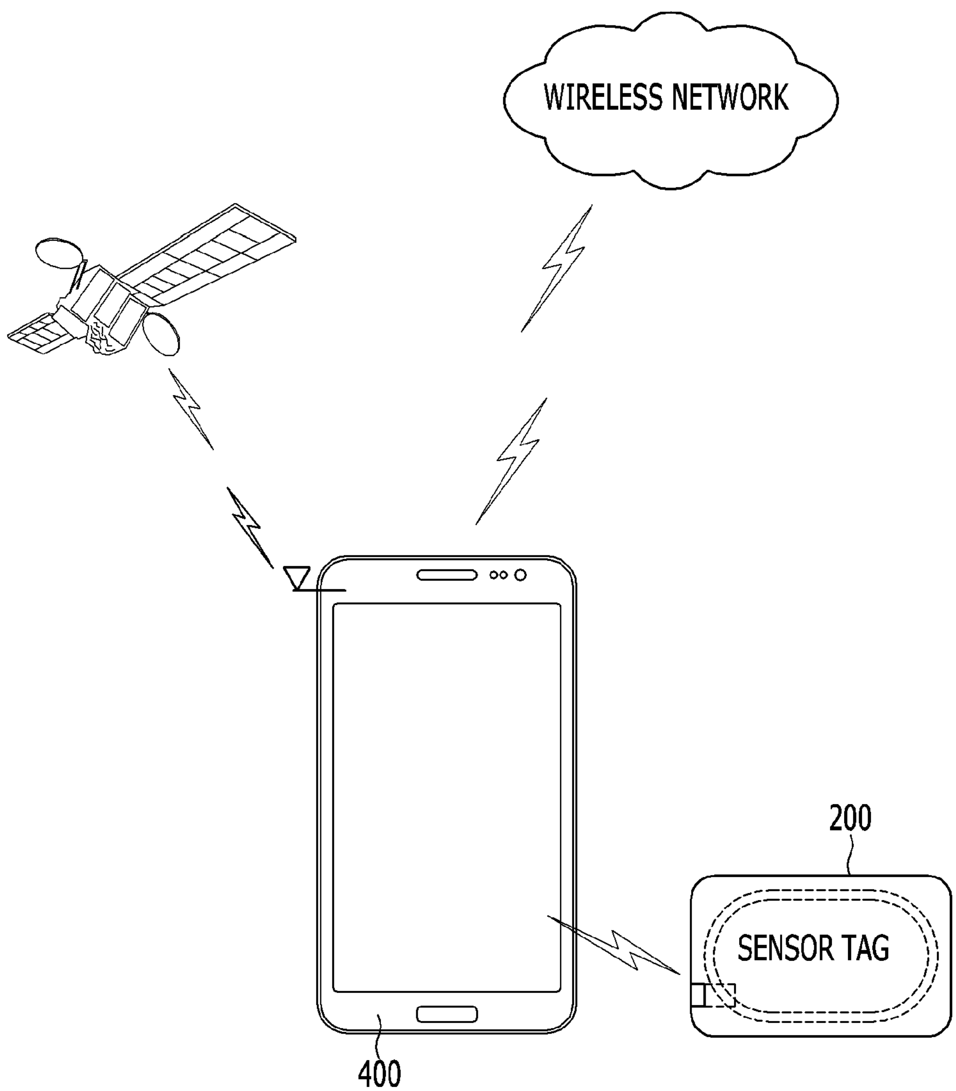


FIG. 19

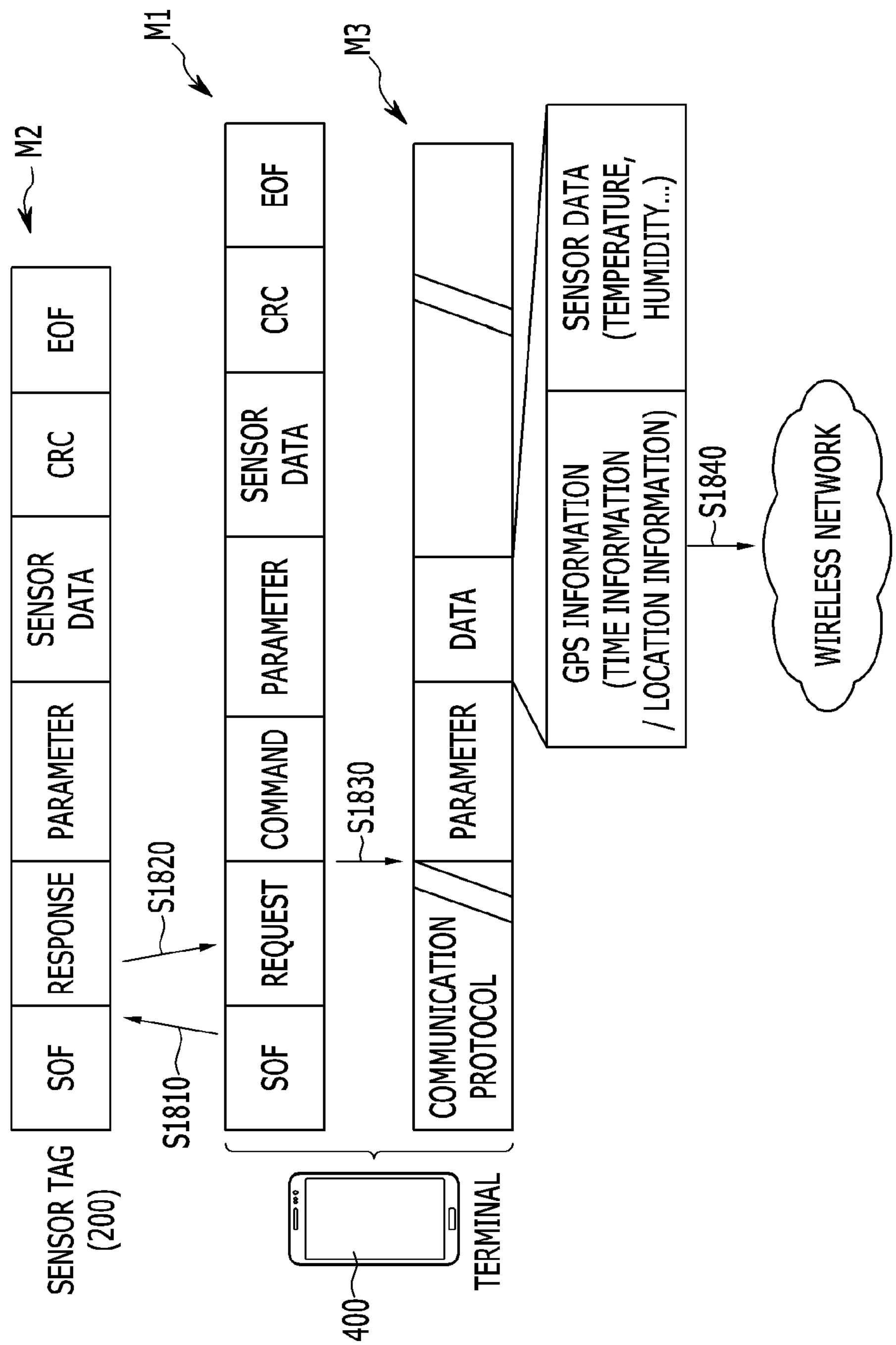

M2
SOF
RESPONSE
PARAMETER
SENSOR DATA
CRC
EOF
SENSOR TAG (200)
S1810
S1820
M1
SOF
REQUEST
COMMAND
PARAMETER
SENSOR DATA
CRC
EOF
S1830
M3
COMMUNICATION PROTOCOL
PARAMETER
DATA
GPS INFORMATION (TIME INFORMATION / LOCATION INFORMATION)
SENSOR DATA (TEMPERATURE, HUMIDITY...)
S1840
WIRELESS NETWORK
400
TERMINAL

FIG. 20

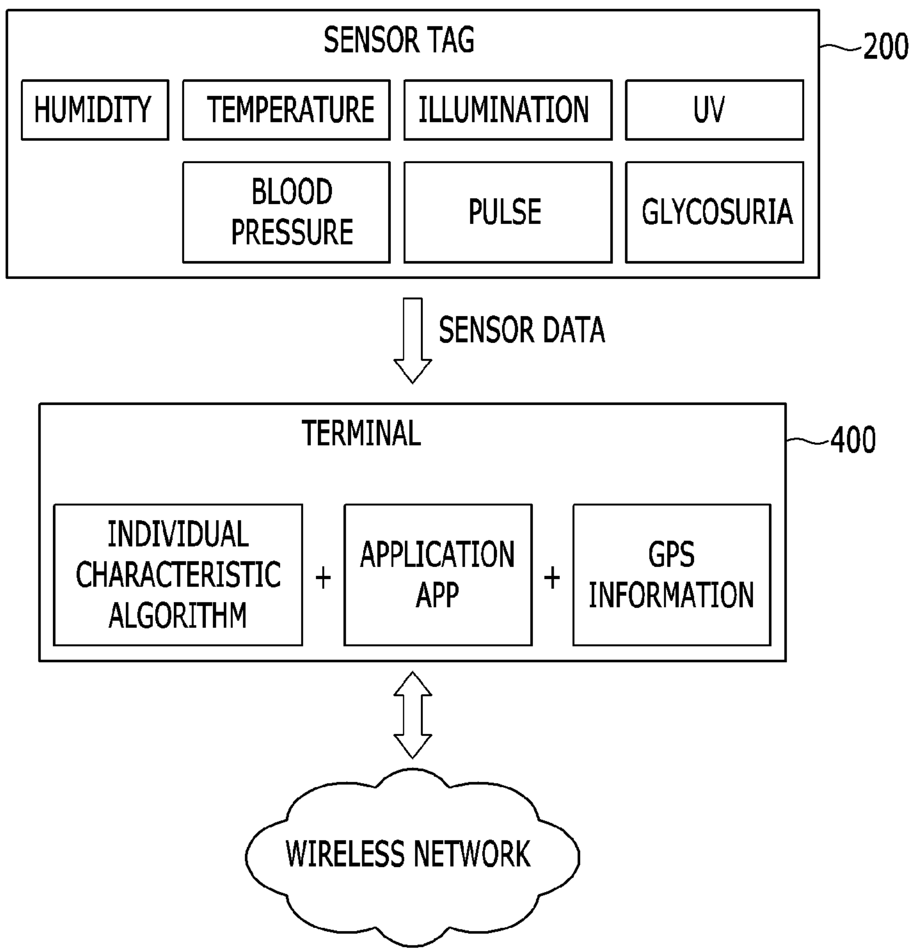
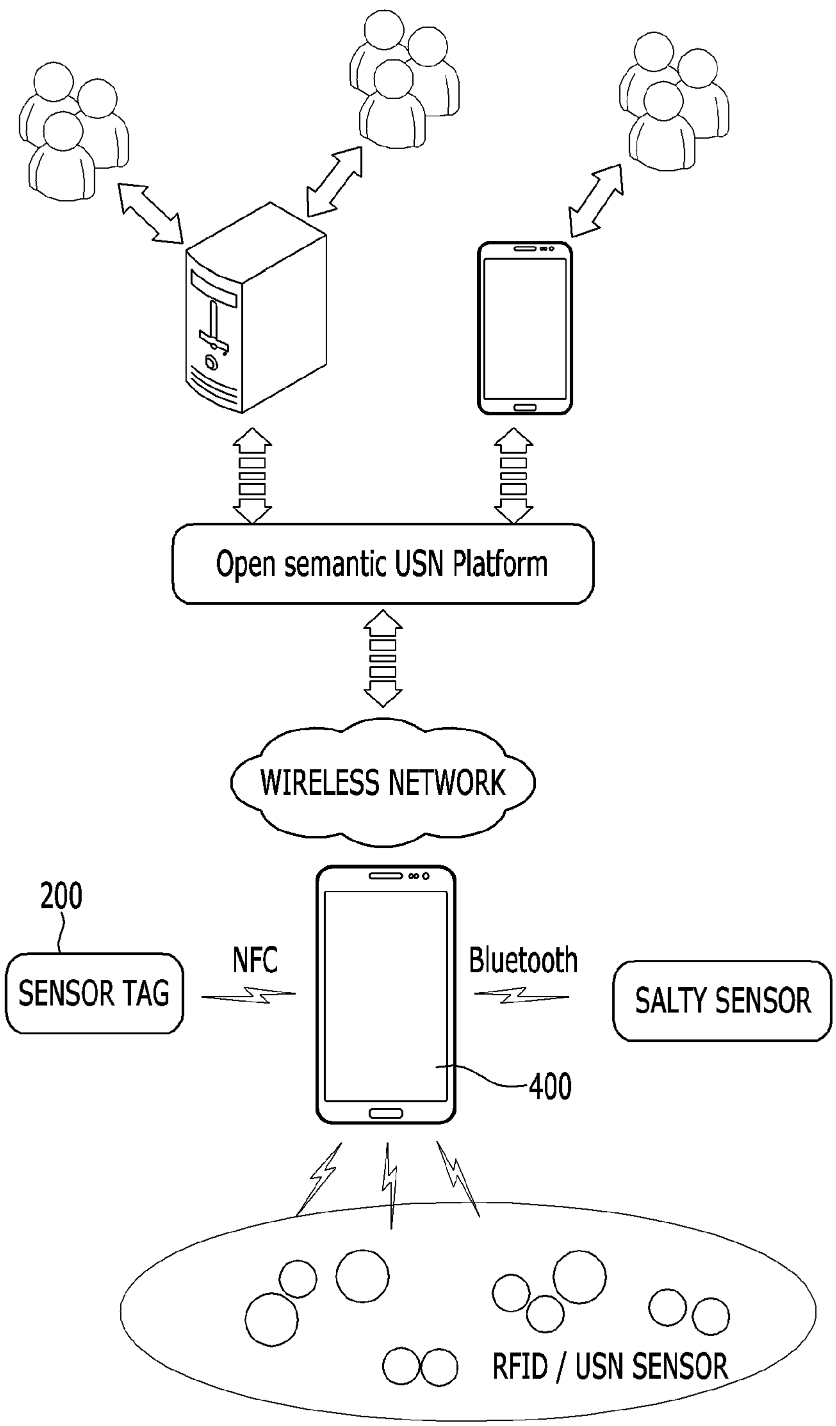

SENSOR TAG
200
HUMIDITY
TEMPERATURE
ILLUMINATION
UV
BLOOD PRESSURE
PULSE
GLYCOSURIA
SENSOR DATA
TERMINAL
400
INDIVIDUAL CHARACTERISTIC ALGORITHM
+
APPLICATION APP
+
GPS INFORMATION
WIRELESS NETWORK

FIG. 21


Open semantic USN Platform
WIRELESS NETWORK
200
SENSOR TAG
NFC
Bluetooth
SALTY SENSOR
400
RFID / USN SENSOR

SENSOR TAG AND METHOD OF PROVIDING SERVICE USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application Nos. 10-2012-0130557 and 10-2013-0123561 filed in the Korean Intellectual Property Office on Nov. 16, 2012 and Oct. 16, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention a sensor tag and a method of providing a service using the same. More particularly, the present invention relates to a radio frequency identifier (RFID) sensor tag to which at least one sensor is attached.

(b) Description of the Related Art

In conventional sensor tags, because power consumption of sensors is large, data of the sensor tags were stored and used using a separate power supply apparatus (a battery). Because of a battery of such a sensor tag, there was a large difficulty in commercial application in an aspect of size and cost of the sensor tag.

Conventional smart terminals provide sensor data itself only to a server through a wireless network according to execution of an RFID reader function of near field communication (NFC). Accordingly, because there is no additional function such as a location and a time that a user requires, real-time sensor data of the spot cannot be verified.

Further, in order to develop a sensor tag into an NFC sensor card product, by developing a separate sensor NFC chip and interlocking the separate sensor NFC chip with a sensor, the sensor tag can be formed in the NFC sensor card product. However, in this case, when developing a small quantity of sensor products of a wide variety of products to a commercially available product, it is expensive.

SUMMARY OF THE INVENTION

The present invention has been made in an effort to provide a sensor tag and a method of providing a service using the same having advantages of being capable of storing sensor data to a sensor tag without attaching a separate power supply apparatus and providing various additional information.

An exemplary embodiment of the present invention provides a sensor tag that communicates with a reader. The sensor tag includes a tag chip, at least one sensor, and a micro controller unit (MCU). The tag chip receives a driving voltage that is generated from a radio frequency (RF) signal that is received from the reader, and transmits sensor data to the reader according to a request from the reader. The at least one sensor receives a necessary driving voltage from the tag chip and measures corresponding sensor data. The MCU receives a necessary driving voltage from the tag chip and transfers sensor data that is measured from the at least one sensor to the tag chip.

The tag chip may include a data storage memory that stores sensor data that is measured from the at least one sensor.

The MCU may include a data storage memory that stores sensor data that is measured from the at least one sensor.

The tag chip and the MCU may be formed into one chip.

The sensor tag may further include an energy harvest device that charges a DC voltage and that supplies the DC voltage to the at least one sensor and the MCU.

The energy harvest device may include: a solar cell that converts light energy from the sun to a DC voltage; a charging battery that charges a DC voltage that is converted by the solar cell; a DC-DC converter that converts and supplies a DC voltage that is charged at the charging battery to a driving voltage necessary for the at least one sensor and the MCU; and a switch that selectively connects the charging battery and the DC-DC converter.

The switch may connect the charging battery and the DC-DC converter when the switch receives a control signal from the outside or when a DC voltage of the charging battery exceeds a threshold voltage.

The energy harvest device may further include a battery that is charged with a DC voltage. The switch may selectively connect the DC-DC converter to the battery or the charging battery.

The energy harvest device may include: a rectifier that rectifies the RF signal to a DC voltage; a charging battery that charges the rectified DC voltage; a DC-DC converter that converts and supplies a DC voltage that is charged at the charging battery to a driving voltage necessary for the at least one sensor and the MCU; and a switch that selectively connects the charging battery and the DC-DC converter.

The switch may connect the charging battery and the DC-DC converter when the switch receives a control signal from the outside or when a DC voltage of the charging battery exceeds a threshold voltage.

The energy harvest device may further include a regulator that stabilizes the rectified DC voltage and that transfers the DC voltage to the charger.

The MCU may sequentially operate the at least one sensor.

The MCU may include an analog and digital interface that is connected to the at least one sensor.

The MCU may download and store at least one of a program and a protocol for controlling the tag chip and the at least one sensor.

Another embodiment of the present invention provides a method of providing a service using a sensor tag in a terminal. The method may include: transmitting a radio frequency (RF) signal that requests sensor data to the sensor tag; receiving sensor data from the sensor tag operating by a driving voltage that is generated from the RF signal; acquiring location information and time information of the terminal; and providing a service that couples the sensor data and the location information and the time information of the terminal, wherein the sensor tag includes a tag chip, a micro controller unit (MCU), and at least one sensor, a voltage necessary for the MCU and the at least one sensor is supplied from a driving voltage that is generated from the RF signal by the tag chip, and sensor data of the at least one sensor is stored at the tag chip or the MCU by the MCU.

The providing of a service may include encrypting the sensor data into location information and time information of the terminal.

The tag chip or the MCU may download and store at least one of a program and a protocol for controlling the at least one sensor.

The providing of a service may include transmitting the sensor data to a wireless network according to a wireless communication protocol.

The providing of a service may include providing an individual characterized service by coupling the sensor data and the location information, the time information, and individual information of the terminal.

The sensor tag may further include an energy harvest device that charges a DC voltage and that supplies the DC voltage to the MCU and the at least one sensor, as needed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are diagrams illustrating an RFID system according to an exemplary embodiment of the present invention.

FIGS. **3** and **4** are diagrams illustrating a signal that is requested in a sensor tag.

FIGS. **5** and **6** are diagrams specifically illustrating an MCU of FIG. **1**.

FIG. **7** is a flowchart illustrating a method of operating a tag sensor according to an exemplary embodiment of the present invention.

FIG. **8** is a diagram illustrating another example of a sensor tag of FIG. **1**.

FIG. **9** is a flowchart illustrating a method of operating the sensor tag of FIG. **8**.

FIGS. **10** to **12** are diagrams illustrating an example of an energy harvest device of FIG. **8**.

FIGS. **13** to **15** are diagrams illustrating an example of a tag chip of FIG. **1**.

FIG. **16** is a diagram illustrating a program download method in an MCU according to an exemplary embodiment of the present invention.

FIG. **17** is a diagram illustrating an example of a form of a sensor tag according to an exemplary embodiment of the present invention.

FIG. **18** is a diagram illustrating an example of a service that is provided in a terminal using a tag sensor according to an exemplary embodiment of the present invention.

FIG. **19** is a diagram illustrating an example of a communication protocol for the service of FIG. **18**.

FIGS. **20** and **21** are diagrams illustrating another example of a service that is provided in a terminal using a tag sensor according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In the following detailed description, only certain exemplary embodiments of the present invention have been shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

In addition, in the entire specification and claims, unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising" will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

Hereinafter, a sensor tag and a method of providing a service using the same according to an exemplary embodiment of the present invention will be described in detail with reference to the drawings.

FIGS. **1** and **2** are diagrams illustrating an RFID system according to an exemplary embodiment of the present invention.

Referring to FIGS. **1** and **2**, the RFID system includes a reader **100** and a sensor tag **200**.

The reader **100** transmits a radio frequency (RF) signal to the sensor tag **200** and receives an RF response signal to the RF signal from the sensor tag **200**.

The sensor tag **200** receives an RF signal from the reader **100** and transmits an RF response signal including a unified identification code and sensor data (hereinafter referred to as "tag data") that the sensor tag **200** has to the reader **100**. The sensor tag **200** generates power from an RF signal or generates power using an energy harvest device and uses the power as a driving voltage, thereby operating without an external battery.

Referring to FIG. **1**, the sensor tag **200** includes a tag antenna **205**, a tag chip **210**, a micro controller unit (MCU) **220** and a plurality of sensors **230_1-230_n**. In this case, as shown in FIG. **2**, the tag chip **210** and the MCU **220** are integrated into one to form a tag chip & MCU **210'** corresponding to one chip.

The tag antenna **205** receives an RF signal and transfers the RF signal to the tag chip **210**.

The tag chip **210** performs wireless communication and includes an input/output (I/O) interface. The tag chip **210** communicates with the reader **100** through wireless communication and communicates with the MCU **220** through the I/O interface.

Further, the tag chip **210** generates a driving voltage from the received RF signal and supplies the driving voltage to the tag chip **210**, the MCU **220**, and the sensors **230_1-230_n**.

The MCU **220** includes the I/O interface and an analog and digital interface, and may be formed in a program. The MCU **220** may communicate with the tag chip **210** through the I/O interface, and may communicate with the sensors **230_1-230_n** through the analog and digital interface.

The sensors **230_1-230_n** measure data at an installed location, and transfer the measured sensor data to the MCU **220** through the analog and digital interface.

The sensors **230_1-230_n** may each be one of a life environment sensor such as a temperature sensor, a humidity sensor, an illumination sensor, an ultraviolet ray (UV) sensor, and a health check sensor, and a bio sensor such as a blood pressure sensor, a pulse sensor, and a glycosuria sensor.

FIGS. **3** and **4** are diagrams illustrating a signal that is requested in a sensor tag.

Referring to FIG. **3**, the MCU **220** receives and operates an input of an enable signal and a voltage necessary for driving from the tag chip **210**, and transfers a sensor driving signal (sensing) to the sensors **230_1-230_n** to operate the sensors **230_1-230_n**. The sensor driving signal (sensing) may include a voltage necessary for driving of the sensors **230_1-230_n**.

The sensors **230_1-230_n**, having received the sensor driving signal (sensing) measure sensor data and transfer the measured sensor data to the MCU **220**.

The MCU **220** receives sensor data from the sensors **230_1-230_n** and stores the sensor data at a data storage memory, for example, an electrically erasable programmable read-only memory (EEPROM) of the tag chip **210**.

As shown in FIG. **4**, the MCU **220** may receive and operate only a driving voltage from the tag chip **210**.

FIGS. **5** and **6** specifically illustrate the MCU **220** of FIG. **1**, and FIG. **5** illustrates only six sensors **230_1-230_6** for convenience, and it is assumed that the sensors **230_1-230_3** are analog sensors and the remaining sensors **230_4-230_6** are digital sensors.

Referring to FIG. **5**, the MCU **220** includes an analog to digital converter (ADC) **222**, a multiplexer **224**, and a digital interface **226**.

The ADC **222** converts analog sensor data that is output from the multiplexer **224** to digital sensor data and transfers the digital sensor data to the tag chip **210**.

The multiplexer **224** selects one of analog sensor data from the sensors **230_1-230_3** corresponding to an analog sensor according to sensor enable signals e1-e3, and outputs the selected analog sensor data to the ADC **222**.

The sensor enable signals e1-e3 are transferred to the sensors **230**$_1$-**230**$_3$, respectively, by a control program of the MCU **220**, and a high level of sensor enable signals e1-e3 may be sequentially transferred to the sensors **230**$_1$-**230**$_3$, respectively.

The sensors **230**$_1$-**230**$_3$ are activated to a high level of the sensor enable signals e1-e3 to measure sensor data and to output the sensor data to the multiplexer **224**.

The multiplexer **224** may select and output analog sensor data of the sensor **230**$_1$ in response to a high level of the sensor enable signal e1, select and output analog sensor data of the sensor **230**$_2$ in response to a high level of the sensor enable signal e2, and select and output analog sensor data of the sensor **230**$_3$ in response to a high level of the sensor enable signal e3.

The digital interface **226** may include an inter-integrated circuit (I2C) **2261**, a serial peripheral interface (SPI) **2262**, and a universal asynchronous receiver/transmitter (UART) **2263**, and may further include other digital interfaces.

The sensors **230**$_4$-**230**$_6$ corresponding to a digital sensor may be connected to one of the I2C **2261**, the SPI **2262**, and the UART **2263**. The I2C **2261**, the SPI **2262**, and the UART **2263** enable the sensors **230**$_4$-**230**$_6$ to approach the tag chip **210**. As shown in FIG. **5**, the sensors **230**$_4$-**230**$_6$ may be connected to the I2C **2261**, the SPI **2262**, and the UART **2263**, respectively, and as shown in FIG. **6**, all sensors **230**$_4$-**230**$_6$ may be connected to the I2C **2261**. When all sensors **230**$_4$-**230**$_6$ are connected to one interface, for example, the I2C **2261**, the sensor tag **200** may be further simplified. In this case, the MCU **220** operates as a master, the sensors **230**$_4$-**230**$_6$ and the tag chip **210** operate as slaves, and the sensors **230**$_4$-**230**$_6$ may be sequentially operated by the MCU **220**.

FIG. **7** is a flowchart illustrating a method of operating a tag sensor according to an exemplary embodiment of the present invention.

Referring to FIG. **7**, the reader **100** broadcasts an RF signal that requests a unified identifier (UID) (S**710**).

When the tag chip **210** of the sensor tag **200** receives the RF signal that requests an UID, the tag chip **210** transmits an RF response signal including the UID of the sensor tag **200** to the reader **100** (S**720**).

The reader **100** determines an UID from the RF response signal that is received from the sensor tag **200** and recognizes the sensor tag **200**.

The tag chip **210** of the sensor tag **200** generates a driving voltage from the RF signal that is received from the reader **100** through the tag antenna **205**, drives the tag chip **210**, and supplies a driving voltage of the MCU **220** and the sensor **230**$_1$ to the MCU **220** and the sensor **230**$_1$ (S**730**, S**730'**). In this case, an enable signal together with a driving voltage may be transferred to the MCU **220**.

When the MCU **220** receives a supply of a driving voltage from the tag chip **210**, the MCU **220** starts operation, transfers a sensor driving signal (sensing) to the sensors **230**$_1$-**230**$_n$, and drives the sensor **230**$_1$ (S**740**). In this case, a voltage necessary for driving of the sensors **230**$_1$-**230**$_n$ may be supplied by the tag chip **210**.

The sensor **230**$_1$ measures sensor data according to the sensor driving signal (sensing) and transfers the sensor data to the MCU **220** (S**750**).

The MCU **220** transfers the sensor data of the sensor **230**$_1$ that is received from the sensor **230**$_1$ to the tag chip **210** (S**760**).

The tag chip **210** stores the received sensor data of the sensor **230**$_1$ at a data storage memory (S**770**).

FIG. **7** illustrates only one sensor **230**$_1$ for convenience, but in a plurality of sensors **230**$_1$-**230**$_n$, the MCU **220** sequentially transfers a sensor driving signal (sensing) to the sensors **230**$_1$-**230**$_n$. When collecting sensor data, the sensors **230**$_1$-**230**$_n$ consume much power. Because much power is consumed in operation of the sensors **230**$_1$-**230**$_n$, the MCU **220** does not simultaneously operate the sensors **230**$_1$-**230**$_n$, lowers instantaneous maximum power by sequentially driving the sensors **230**$_1$-**230**$_n$, and enables a power abnormality to not occur in operation of the sensor tag **200**. That is, the MCU **220** logs sensor data of the sensors **230**$_1$-**230**$_n$ at the tag chip **210** with a method of transferring a sensor driving signal (sensing) to one sensor, storing sensor data that is received from one sensor at the tag chip **210**, and transferring the sensor driving signal (sensing) to another sensor. Thereby, the MCU **220** may transfer the sensing to only a necessary sensor of the sensors **230**$_1$-**230**$_n$.

In this case, because the MCU **220** receives a driving voltage from the tag chip **210**, the MCU **220** may control the sensors **230**$_1$-**230**$_n$ to collect sensor data of the sensors **230**$_1$-**230**$_n$ within a predetermined time.

In order to read sensor data, the reader **100** transmits an RF signal that requests to read to the tag chip **210** (S**780**).

The tag chip **210** transmits an RF response signal including sensor data that is stored at the data storage memory to the reader **100** (S**790**).

FIG. **8** is a diagram illustrating another example of the sensor tag of FIG. **1**.

Referring to FIG. **8**, a sensor tag **200'** may further include an energy harvest device **240** and a display **250**.

The energy harvest device **240** generates and charges a driving voltage. The energy harvest device **240** recognizes an external control or a charged voltage, requests power supply to a tag chip **210**, converts a voltage that is charged at the energy harvest device **240** to a driving voltage of an MCU **220** and sensors **230**$_1$-**230**$_n$, and supplies the driving voltage to the MCU **220** and the sensors **230**$_1$-**230**$_n$. The energy harvest device **240** may supply a driving voltage to the tag chip **210**. When the MCU **220** and the sensors **230**$_1$-**230**$_n$ receive a supply of a driving voltage, the MCU **220** and the sensors **230**$_1$-**230**$_n$ start driving.

Such an energy harvest device **240** may include, for example, a power supply module using a solar cell or/and a power supply module using an RF.

The display **250** displays stored tag data.

FIG. **9** is a flowchart illustrating a method of operating the sensor tag of FIG. **8**.

Referring to FIG. **9**, when an external control or a charged voltage arrives at a threshold voltage, the energy harvest device **240** requests power supply to the tag chip **210** (S**910**).

Thereafter, the energy harvest device **240** supplies a driving voltage to the MCU **220** and the sensor **230**$_1$ using a charged voltage of the energy harvest device **240** (S**920**, S**920'**).

When the MCU **220** receives a supply of a driving voltage, the MCU **220** transfers a sensor driving signal (sensing) to the sensor **230**$_1$ and drives the sensor **230**$_1$ (S**930**).

The sensor **230**$_1$ measures sensor data according to the sensor driving signal (sensing) and transfers the sensor data to the MCU **220** (S**940**).

The MCU **220** transfers the sensor data that is received from the sensor **230**$_1$ to the tag chip **210** (S**950**).

The tag chip **210** stores the received sensor data of the sensor **230**$_1$ at a data storage memory. After sensor data of an entire sensor of the sensor tag **200** is stored at the data storage memory with such a method, the tag chip **210** transfers a completion signal to the energy harvest device **240** (S**960**). Therefore, the energy harvest device **240** stops power supply.

In this way, sensor data may be logged to the tag chip **210** with power that is generated by the energy harvest device **240** instead of an RF signal according to a UID request. For example, at a location where light exists, when installing the sensor tag **200** for a predetermined period, data may be logged without a separate battery, and at a location in which an RF signal occurs, when installing the sensor tag **200** for a predetermined period, data may be logged without a separate battery.

FIGS. **10** to **12** are diagrams illustrating an example of the energy harvest device of FIG. **8**.

Because a voltage that that is supplied from the tag chip **210** is different from a voltage that the sensors **230**$_1$-**230**$_n$ require, when the sensors **230**$_1$-**230**$_n$ cannot perform a smooth operation, an energy harvest device of FIGS. **10** to **12** solves this problem.

Referring to FIG. **10**, the energy harvest device **240** may include a rectifier **241**, a charging battery **242**, a switch **243**, and a DC-DC converter **244**. The rectifier **241**, the charging battery **242**, the switch **243**, and the DC-DC converter **244** may correspond to a power supply module using an RF.

The rectifier **241** rectifies (converts) an RF signal that is received through an antenna to a DC voltage and outputs the RF signal to the charging battery **242**. Here, the antenna is an RF antenna and may be a tag antenna.

The charging battery **242** charges a DC voltage that is rectified by the rectifier **241**. Such a charging battery **242** may be formed with a capacitor. In this case, in order to stabilize a DC voltage that is output from the rectifier **241**, a regulator may be added between the rectifier **241** and the charging battery **242**.

When the switch **243** is turned on, the switch **243** connects the charging battery **242** and the DC-DC converter **244** and transfers a DC voltage that is charged at the charging battery **242** to the DC-DC converter **244**. The switch **243** may be turned on by an external control, and when a voltage of the charging battery **242** arrives at a threshold voltage, the switch **243** may be turned on. In the sensors **230**$_1$-**230**$_n$, when collection (sensing) of sensor data is necessary, an external control may be performed by a manager.

The DC-DC converter **244** converts a DC voltage of the charging battery **242** to a DC voltage Vdd_H appropriate for driving of the MCU **220** and the sensors **230**$_1$-**230**$_n$, and supplies the converted DC voltage Vdd_H to the MCU **220** and the sensors **230**$_1$-**230**$_n$. In some cases, the DC-DC converter **244** may supply a DC voltage Vdd_H to the tag chip **210**.

Referring to FIG. **11**, an energy harvest device **240'** may include a solar cell **241'**, a charging battery **242**, a switch **243**, and a DC-DC converter **244**. The solar cell **241'**, the charging battery **242**, the switch **243**, and the DC-DC converter **244** may correspond to a solar cell power supply module.

The charging battery **242**, the switch **243**, and the DC-DC converter **244** are the same as those that are described with reference to FIG. **10**.

The solar cell **241'** directly converts light energy from the sun to electrical energy, and electrical energy that is converted by the solar cell **241'** is DC power. DC power is charged at the charging battery **242** by the solar cell **241'**.

Referring to FIG. **12**, an energy harvest device **240"** includes a battery **245**, a switch **243'**, and a DC-DC converter **244**. The battery **245**, the switch **243'**, and the DC-DC converter **244** may correspond to a battery power supply module.

The battery **245** charges a DC voltage.

The switch **243'** transfers a DC voltage of the battery **245** to the DC-DC converter **244** according to an external control.

The energy harvest device **240** or **240'** of FIG. **10** or **11** may be connected to such a battery power supply module. For example, the energy harvest device **240"** may further include a solar cell **241'** and a charging battery **242**. Further, the energy harvest device **240"** may further include a rectifier **241** and a charging battery **242**.

In this case, when an external control or a voltage of the charging battery **242** arrives at a threshold voltage, the switch **243'** transfers a DC voltage of the charging battery **242** to the DC-DC converter **244**. The battery **245** may be stably used for a long time with such a method.

Further, the energy harvest devices **240** and **240'** may be coupled into one, and an energy harvest device of various forms may be embodied.

FIGS. **13** to **15** are diagrams illustrating an example of the tag chip of FIG. **1**.

Referring to FIG. **13**, the tag chip **210** may include an RF transmitter/receiver **212**, a processor **214**, and an I/O interface **216**.

The RF transmitter/receiver **212** is connected to the processor **214** through power supply lines (Vdd and GND), a receiving signal line (RX), a transmitting signal line (TX), a clock signal line (CLK), and a power on reset line (PoR). Power is supplied to the RF transmitter/receiver **212** and the processor **214** through the power supply lines Vdd and GND. The receiving signal line RX transfers data from the processor **214** to the RF transmitter/receiver **212**, and the transmitting signal line TX transfers an RF signal that is received through the tag antenna **205** to the processor **214**. The RF signal is modulated to a digital signal by the RF transmitter/receiver **212** to be transferred to the processor **214** through the transmitting signal line TX, and data that is received from the processor **214** is demodulated by the RF transmitter/receiver **212** to be transferred to the reader **100** through the tag antenna. When power is supplied to the processor **214**, the PoR transfers an enable signal that resets the processor **214** to the processor **214**, and the CLK transfers a clock signal from the RF transmitter/receiver **212** to the processor **214**.

The processor **214** performs an RFID standard protocol. The processor **214** may form an RFID standard protocol with logic of the processor **214**. The RFID standard protocol may be ISO 15693, ISO 14443, and ISO 18000-3.

The processor **214** is formed by forming a protocol in a hardware component. The processor **214** may include a memory **2141**. Here, the memory **2141** is an EEPROM and is a location that stores sensor data. That is, referring to FIGS. **13** and **14**, a tag chip **210** having the memory **2141** and a tag chip **210'** not having the memory **2141** may be distinguished. In the tag chip **210'** not having the memory **2141**, the MCU **220** may store sensor data.

Further, with respect to a protocol, a tag chip having a protocol and a tag chip having no protocol may be distinguished. When a protocol is included in the tag chip **210**, a control program appropriate to the sensors **230**$_1$-**230**$_n$ is downloaded to the tag chip **210**, and when a protocol does not exist at the tag chip **210**, a control program and a protocol appropriate for the sensors **230**$_1$-**230**$_n$ are downloaded to the MCU **220**. When a protocol does not exist at the tag chip **210**, the tag chip **210** may operate by interlocking with the MCU **220**.

The I/O interface **216** connects the tag chip **210** and the MCU **220**. The I/O interface **216** and the MCU **220** are connected through power supply lines (Vdd and GND), a serial data line (SDA), and a serial clock line (SCL). In this case, the MCU **220** is a master, and the I/O interface **216** is a slave. The SCL is a signal line that transfers a synchronous clock signal for transferring data, and is a unidirectional signal line to transfer data from a master to a slave. The SDA is a signal line for transferring data, and is a bi-directional signal line that can transfer data from a master to a slave or that can transfer data from a slave to a master. As such an I/O interface **216**, **120**, SPI, and UART may be used.

In this way, the tag chip **210** is an independent chip and may operate by interlocking with another device such as the MCU **220** through the I/O interface **216**.

Referring to FIG. **15**, a tag chip **210"** includes only an RF transmitter/receiver **212'**. That is, the processors **214** and **214'** and the I/O interface **216** may be removed from the tag chips **210** and **210'** of FIGS. **13** and **14**. Such a tag chip **210"** corresponds to a tag chip having no protocol.

The RF transmitter/receiver **212'** may be connected to the MCU **220** through power supply lines (Vdd and GND), a receiving signal line (RX), a transmitting signal line (TX), a clock signal line (CLK), and a PoR line (PoR). In this case, an RFID standard protocol may be performed in the MCU **220**, and the MCU **220** may download and store an RFID standard protocol.

A sensor to use at the spot has various functions and kinds. When producing a tag chip appropriate for such a sensor, it is expensive. A method of enhancing this is to download and use a program appropriate for the tag chip **210** and use sensors by connecting the tag chip **210** and the use sensors about the MCU **220**.

FIG. **16** is a diagram illustrating a program download method in an MCU according to an exemplary embodiment of the present invention.

As shown in FIG. **16**, the MCU **220** may connect the tag chip **210** and the use sensors $\mathbf{230_1}$-$\mathbf{230_n}$, and download a control program appropriate for the tag chip **210** and the use sensors $\mathbf{230_1}$-$\mathbf{230_n}$ from a computer **300**. Further, as shown in FIG. **14**, when the tag chip **210'** is formed with only the RF transmitter//receiver **212'**, the MCU **220** may download an RFID standard protocol from the computer **300**.

In this way, because the MCU **220** downloads and operates an RFID standard protocol and a control program appropriate for the tag chip **210** and the use sensors $\mathbf{230_1}$-$\mathbf{230_n}$, the MCU **220** may be used as a programmable sensor tag.

Further, the MCU **220** may store sensor data. In this case, the MCU **220** may include a data storage memory.

FIG. **17** is a diagram illustrating an example of a form of a sensor tag according to an exemplary embodiment of the present invention.

A sensor tag **200** may be produced in various shapes according to actual use in an actual spot.

As shown in FIG. **17**, the sensor tag **200** may be formed in a geometrical (circle, rectangle, etc.) form in consideration of performance of a credit card, the sensor tag **200**, and sensors $\mathbf{230_1}$-$\mathbf{230_n}$. Further, by forming a groove for a function and performance in the sensor tag **200**, the sensor tag **200** may be attached to the groove, and by forming a hole in the sensor tag **200**, the sensor tag **200** may be hung at a constant location.

Further, by attaching the sensors $\mathbf{230_1}$-$\mathbf{230_n}$ to an NFC card based on short range wireless communication (WiFi, Bluetooth, Zigbee, etc.), the sensor tag **200** may be formed.

FIG. **18** is a diagram illustrating an example of a service that is provided in a terminal using a tag sensor according to an exemplary embodiment of the present invention.

Referring to FIG. **18**, a terminal **400** is a terminal having a reader function and a wireless communication function and may be, for example, an NFC terminal.

The terminal **400** may acquire sensor data from a tag sensor **200** by turning on a reader function. Further, the terminal **400** may receive a GPS signal from a satellite and acquire GPS information (location, time).

Further, the terminal **400** may acquire accurate location information by coupling to a sensor within the terminal **400**, and when a GPS signal is weak, the terminal **400** may acquire location information using only a sensor within the terminal **400**. For example, the terminal **400** may acquire an accurate location using a GPS signal with an acceleration sensor, a gyro sensor, a magnetic field sensor, and an altitude sensor within the terminal **400**. Resultantly, the terminal **400** may provide location and time information to a desired user through a wireless network.

The terminal **400** may provide GPS information together with sensor data that is acquired from the tag sensor **200** to a desired user through the wireless network. A person having received this service can simultaneously obtain sensor data and location and time information of a sensor using the terminal **400** of the user. When only sensor data is transferred from the terminal **400** to the wireless network, a location and a time are not known and thus a sensor value of an actual location and a measurement time of the sensor may be notified to the user as false information. In this case, when using GPS information, safe sensor information and an accurate location and time may be provided.

Because a sensor tag service by the terminal **400** may know sensor information and a location and measurement time of the sensor at any time and place, the sensor tag service can realize various new services. As a specific example of the sensor tag service, when a user using the sensor tag **200** enters an individual house, sensor data is received from the sensor tag **200** at a front door or a specific location through the terminal **400**. In this case, when sensor data is a temperature, humidity, and illumination, the terminal **400** may control an indoor environment within the house to correspond to an optimal environment for a user from temperature, humidity, and illumination data. For example, the terminal **400** may control a boiler, a humidifier/dehumidifier, and lighting of a house to be an optimal environment that a user wants. Such an indoor environment control may be performed by interlocking with wireless communication of the terminal **400**.

Further, in order to stably process important sensor data, the terminal **400** may encrypt sensor data. For example, the terminal **400** may encrypt sensor data into time and location information by a GPS signal. In this way, encrypted sensor data may be used for information security and fabrication/falsification.

FIG. **19** is a diagram illustrating an example of a communication protocol for the service of FIG. **18**.

Referring to FIG. **19**, when the terminal **400** transfers a message M1 that requests sensor data to the sensor tag **200** by an NFC communication protocol by turning on a reader function (S**1810**), the sensor tag **200** transmits a response message M2 including sensor data to the terminal **400** (S**1820**).

The terminal **400** converts the received response message M2 to a message M3 corresponding to a wireless communication protocol (S**1830**) and transmits GPS information (location and time) and sensor data to a wireless network (S**1840**). The message M3 that is transmitted to the wireless network is transferred to a necessary user.

When the terminal **400** receives a response message from the wireless network, the terminal **400** finishes a wireless network interlocking service.

When the terminal **400** cannot acquire GPS information, the terminal **400** may use a location and a time by a wireless network.

In an NFC communication method between the sensor tag **200** and the terminal **400**, in order to smoothly transmit/receive sensor data, a command and a parameter of a protocol and a size and a location of data may be easily obtained using an existing RFID protocol. For example, when each command is set to 1 byte, each parameter is set to 1 byte, and sensor data is set to 2 bytes, a location of each sensor data may be set in order of temperature, humidity, . . . , and illumination. By setting a parameter code and a command code thereof, the parameter and the command may be obtained.

In a method of transmitting/receiving sensor data by wireless communication, a command and a parameter having GPS information and sensor data and a size and a location of data may be easily obtained using an existing wireless protocol. A general message structure of a protocol may be formed similar to that of FIG. **19**. That is, by additionally forming a command of a protocol transmitting sensor data, a system may be smoothly formed.

FIGS. **20** and **21** are diagrams illustrating another example of a service that is provided to a terminal using a tag sensor according to an exemplary embodiment of the present invention.

Referring to FIG. **20**, temperature, humidity, illumination, and ultraviolet ray (UV) sensors and a biorhythm measurement sensor that measures individual biorhythms such as blood pressure, pulse, and glycosuria may be attached to the sensor tag **200**. In this way, various sensors may be used for the sensor tag **200**, as needed.

Sensor data that is collected by the temperature, humidity, illumination, and UV sensors and the biorhythm measurement sensor is transmitted to the terminal **400**.

The terminal **400** may provide temperature, humidity, illumination, and UV data, individual biorhythm data, and time and location information to a user. Primary service use of such sensor data may be performed by an application App of the terminal **400**. An application App service may provide sensor data to a user through an application App. Sensor data that is generated by forming an application App may be provided to the user.

Further, in order to realize an intelligent service, the terminal **400** may provide a customized service that is optimized for individual characteristics using individual information and sensor data. Individual information may include, for example, an emotional index, a special ability, and a hobby. Individual information is processed by an individual characteristic algorithm, and by interlocking sensor data with the individual characteristic algorithm as a parameter, a new service may be generated. That is, by interlocking sensor data and individual characteristic algorithm, an optimal customized service may be provided.

The terminal **400** may provide a real-time customized service by further adding location and time information to interlocking of sensor data and the individual characteristic algorithm. Further, the terminal **400** may interlock sensor data and the individual characteristic algorithm and realize various services through a network.

Further, as shown in FIG. **21**, the terminal **400** may receive sensor data through NFC communication with the sensor tag **200**, receive sensor data from a peripheral sensor, for example, a salty sensor and an RFID/USN sensor through Bluetooth communication, and realize secondary various USN services through an open semantic USN platform by transmitting the collected sensor data to a wireless network.

According to an exemplary embodiment of the present invention, by using power generation by an RF or power generation by an energy harvest device, a sensor tag is activated, data is logged in to the sensor tag, and various applications can be performed by a mobile terminal. Further, when a sensor tag and a mobile terminal are interlocked, various services can be realized using time and location information of the mobile terminal.

Further, by attaching a sensor to an NFC card based on short range wireless communication, various application services that are interlocked with a mobile terminal can be realized.

Accordingly, a life related service can be supported using an NFC function and a wireless network, a higher value based on user convenience/reliability can be obtained, a service of various fields can be provided, and an environment of a smart life in which life sensing information and individual sympathy are mixed can be provided.

An exemplary embodiment of the present invention may not only be embodied through the above-described apparatus and/or method, but may also embodied through a program that executes a function corresponding to a configuration of the exemplary embodiment of the present invention or through a recording medium on which the program is recorded, and can be easily embodied by a person of ordinary skill in the art from a description of the foregoing exemplary embodiment.

While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A sensor tag that communicates with a reader, comprising:

a tag chip configured to generate a driving voltage from a radio frequency (RF) signal that is received from the reader and that transmits sensor data to the reader according to a request from the reader;

a sensor configured to receive a supply of a necessary driving voltage from the tag chip and that measures corresponding sensor data; and

a micro controller unit (MCU) configured to receive a necessary driving voltage from the tag chip and configured to transfer sensor data that is measured from the sensor to the tag chip.

2. The sensor tag of claim **1**, wherein the tag chip comprises a data storage memory configured to store sensor data that is measured from the at least one sensor.

3. The sensor tag of claim **1**, wherein the MCU comprises a data storage memory configured to store sensor data that is measured from the sensor.

4. The sensor tag of claim **1**, wherein the tag chip and the MCU are formed into one chip.

5. The sensor tag of claim **1**, further comprising an energy harvest device configured to charge a DC voltage and configured to supply the DC voltage to the sensor and the MCU.

6. The sensor tag of claim **5**, wherein the energy harvest device comprises:

a solar cell configured to convert light energy from the sun to a DC voltage;

a charging battery configured to charge a DC voltage that is converted by the solar cell;

a DC-DC converter configured to convert and su a DC voltage that is charged at the charging battery to a driving voltage necessary for the sensor and the MCU; and

a switch configured to selectively connect the charging battery and the DC-DC converter.

7. The sensor tag of claim **6**, wherein the switch connects the charging battery and the DC-DC converter in response to the switch receiving control signal from the outside or in response to a DC voltage of the charging battery exceeds a threshold voltage.

8. The sensor tag of claim **6**, wherein the energy harvest device further comprises a battery configured to charge a DC voltage, and

wherein the switch selectively connects the DC-DC converter to the battery or the charging battery.

9. The sensor tag of claim **5**, wherein the energy harvest device comprises:

a rectifier configured to rectify the RF signal to a DC voltage;

a charging battery configured to charge the rectified DC voltage;

a DC-DC converter configured to convert and supply a DC voltage that is charged at the charging battery to a driving voltage necessary for the sensor and the MCU; and

a switch configured to selectively connect the charging battery and the DC-DC converter.

10. The sensor tag of claim **9**, wherein the switch connects the charging battery and the DC-DC converter in response to the switch receiving a control signal from the outside or in response to a DC voltage of the charging battery exceeding a threshold voltage.

11. The sensor tag of claim **9**, wherein the energy harvest device further comprises a regulator configured to stabilize the rectified DC voltage and configured to transfer the DC voltage to the charger.

12. The sensor tag of claim **1**, wherein the MCU sequentially operates the at least one sensor.

13. The sensor tag of claim **12**, wherein the MCU comprises an analog and digital interface that is connected to the sensor.

14. The sensor tag of claim **1**, wherein the MCU downloads and stores at least one of a program and a protocol for controlling the tag chip and the sensor.

15. A method of providing a service using a sensor tag in a terminal, the method comprising:

transmitting a radio frequency (RF) signal that requests sensor data to the sensor tag;

receiving sensor data from the sensor tag operating by a driving voltage that is generated from the RF signal;

acquiring location information and time information of the terminal; and

providing a service that couples the sensor data, the location information, and the time information of the terminal,

wherein the sensor tag comprises a tag chip, a micro controller unit (MCU), and a sensor, and

a voltage necessary for the MCU and the at least one sensor is supplied from a driving voltage that is generated from the RF signal by the tag chip, and sensor data of the sensor is stored at the tag chip or the MCU by the MCU.

16. The method of claim **15**, wherein the providing of a service comprises encrypting the sensor data into location information and time information of the terminal.

17. The method of claim **15**, wherein the tag chip or the MCU downloads and stores at least one of a program and a protocol for controlling the sensor.

18. The method of claim **15**, wherein the providing of a service comprises transmitting the sensor data to a wireless network according to a wireless communication protocol.

19. The method of claim **15**, wherein the providing of a service comprises providing an individual characterized service by coupling the sensor data and the location information, the time information, and individual information of the terminal.

20. The method of claim **15**, wherein the sensor tag further comprises an energy harvest device that charges a DC voltage and that supplies the DC voltage to the MCU and the sensor, as needed.

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